PATENT SPECIFICATION
DRAWINGS ATTACHED

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International Classification :—F06l.

COMPLETE SPECIFICATION

Flexible Hydraulic Hose

We, FLEXONICS CORPORATION, a corporation organised under the laws of the State of Illinois, United States of America, of 1315 South Third Avenue, Maywood, Illinois, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention is concerned generally with flexible hoses, and specifically with flexible hose which is suitable for higher pressures than any heretofore known, while being free to flex in use.

Transmission of hydraulic fluid at high pressures through flexible hoses has presented a great many problems for a long time, and not all of these problems have been solved successfully in the past. Hoses of synthetic rubber or of plastic have many desirable features and for many uses have proved satisfactory. However, such hoses have characteristics which militate against their use in some applications.

Corrugated metal hoses have been found satisfactory for many applications requiring flexible lines, and reinforcing rings placed in the corrugations have allowed such corrugated metal hoses to be used at high pressures. However, the reinforcing rings limit the flexibility of corrugated metal hose and if a reinforced corrugated metal hose is flexed to too great a degree, the wall of the hose may no longer be reinforced by one or more of the reinforcing rings, thus subjecting the hose to failure.

In addition to the normal operating pressure to be withstood by a flexible hose, such pressure being static, or dynamic, or a combination of the two, there are shock pressures that must be withstood. The flow produced by motor driven pumps causes pressure to be withstood by a flexible hose, sudden opening or closing of valves, such as electrically operated valves, creates shock waves in a hydraulic system. High frequency vibrations on the order of 8,000 cycles per second and up, such as often are found in machinery, and particularly in aircraft, produce shock waves which are extraordinarily detrimental to the life of flexible tubing. With such high frequency vibrations, there is no time for recoil of the hose or line material and this causes the shock on the hose to be substantially greater than when there is time for recoil.

Accordingly, it is the broad object of this invention to provide a flexible hydraulic hose capable of withstanding steady pressures. and shock pressures to a degree unknown in the prior art.

A hose according to the present invention comprises a plurality of small tubes in contiguous relation, a coupling joined to the tubes at one end of the tubes, the coupling being substantially larger in bore than the individual tubes, and means embracing the plurality of tubes and serving to limit bending of the hose construction.

The means limiting bending may, for example, be a braided sleeve encircling all of the tubes, or a rigid sleeve encircling all of the tubes and flared outwards at one end, and may in addition include a cable extending longitudinally between the tubes, or a plurality of braided sleeves, each encircling one of the tubes.

The accompanying drawings show examples of hoses according to the present invention. In these drawings:—

Figure 1 is a side view of one hose, with an outer sleeve removed:

Figure 2 is a cross section on the line 2-2 in Figure 1;

Figure 3 is a fragmentary longitudinal section on the line 3-3 in Figure 1;

Figure 4 is a cross section on the line 4-4 in Figure 3;

Figure 5 is a section similar to Figure 4 showing a modified hose;

Figure 6 is a side view of a second hose according to the invention, with a sleeve in position, but with parts in section or

broken away;

Figure 7 is a fragmentary longitudinal section on the line 7-7 in Figure 6;

Figure 8 is a cross section on the line 8-8 in Figure 7;

Figure 9 is a side view, partially in section, of a further modified hose;

Figure 10 is a cross section on the line 10-10 in Figure 9;

Figure 11 is an enlarged fragmentary side view of one of the tubes in the hose of Figure 6, part of the tube being shown in section; and

Figure 12 is a view similar to Figure 11, but showing a modified form of tube as used in the hose of Figure 9.

The hose 10 shown in Figures 1 to 4 comprises a plurality of thin wall tubes 12 helically wound together to form a flexible body 14. Each of the tubes 12 is flexible, and by virtue of this and of the helical disposition, the entire body 14 is flexible. The tubes are preferably made of metal such as stainless steel or copper, although other metals may be used, and the tubes could also be made of other materials such as glass, rubber, synthetic rubber, or a plastic.

The hose 10 is provided at each end of the body 14 with a coupling 16 of suitable metal such as stainless steel or brass. Each coupling comprises a hexagonal or other noncircular portion 18 for holding by a wrench, and a screw-threaded neck 20 extending therefrom. A body portion 22 extends from the wrench portion 18 in the opposite direction from the threaded neck 20. The body portion 22 initially is formed solid, thereby presenting a web 24. This web has a plurality of holes 26 bored therein. These holes are of the same diameter as the ends of the thin wall tubes 12, which may be drawn down slightly, and are bored in regular pattern in slightly spaced relation. The holes are equal in number to the tubes, there being 19 tubes and holes in the example shown. The holes are positioned in planes parallel to the faces of the wrench portion 18. The ends of the tubes are inserted into the holes and are secured in place by any suitable means, such as silver brazing, brazing with other materials, soldering, or welding, or by mechanical fittings. A pressure tight joint thereby is fabricated.

A modification is illustrated in Figure 5. In this figure, similar numerals are utilized to identify similar parts with the addition of the suffix *a*. In this construction, the web of the body portion 22*a* is omitted. Instead, the body portion is provided with a longitudinally extending cylindrical opening. The tubes 12*a* simply are inserted into this cylindrical opening, and the interstices among the tubes and between the tubes and the coupling 16*a* are filled with any suitable flowable material such as silver solder 28 to braze or otherwise secure the tubes in place and to form a fluid tight seal with the coupling.

It will be observed in Figure 3 that the internal bore 30 of the threaded portion 20 of the coupling is of less diameter than the outside diameter of the body 14 of the hose, and the same is true with regard to the modification shown in Figure 5. This is permissible inasmuch as the effective diameter of the hose body 14 is substantially less than the outside diameter of the body. The coupling is, however, larger in bore than the tubes.

In the complete hose the tubes are enclosed in a flared sleeve similar to the sleeve 58 shown in Figure 6. This sleeve limits bending of the hose construction so that the tubes cannot be weakened by excessive deformation. Without means limiting bending there is a possibility that the hose might be bent to too sharp an angle, with resulting damage to one or more of the small tubes, such as forcing these tubes out of their normally circular cross section. Continued sharp bending might cause the tubes to break due to fatigue. Furthermore, there is a possibility that high internal pressures might tend to elongate the hose, or to cause it to tend to unwind from its helically twisted condition.

In addition to showing the sleeve 58, Figure 6 shows various possible modifications of other parts. Many of the parts are, however similar to those previously described, and are identified by similar numerals with the addition of the suffix *b*. To avoid prolixity of description, only the changed parts will be noted in detail.

More specifically, the flexible hose 14*b* shown in Figures 6 to 8 comprises a plurality of small tubes 12*b*. These are corrugated tubes having folded-over wall sections 48 arranged annularly around the tubes and providing alternate sections 50 and 52 of minimum and maximum diameter. It will be understood that for flow purposes the effective diameter of each tube is slightly less than the minimum diameter 50, due to turbulence of flow in the vicinity of the wall. Preferably each small tube 12*b*, as best seen in Figure 11, is encircled by a tubular braid 54. This braid preferably is of metal wire but can be made of other filamentary material. It limits bending of the individual tubes 12*b*. it prevents the tubes from rubbing against one another due to relative movement upon bending of the hose, it protects the tubes against physical damage, it provides a physical reinforcement against high internal pressures, and it prevents unwarranted elongation of each tube.

The braid covered tubes 12*b* are helically twisted together as in the previous

examples, and the assembly of tubes is covered with a large mesh braided sleeve 56. The braid[redacted]ered hose body 14*b* thus produced is [redacted]mbled with a pair of threaded coup[redacted]gs 16*b* similar to the couplings 16*a*. That is, the body portion 22*b* has an axial bore therethrough rather than a web having a plurality of small openings therein. The hose body 14*b* is inserted at each end in one of the couplings 16*b* and is held in place therein by a flowable material 28*b* hardened in place. For instance, this can be silver braze, or some other type of solder, or a weld, or, particularly in the case of a non-metallic tube, this could be a suitable cement.

Outside the braid 56 is the sleeve 58 of rigid construction surrounding the hose, forming a fairly tight fit therewith at the centre, and flared outwards at the opposite ends at 60. This guard is preferably a metal sleeve, but it will be understood that other materials could be used for this purpose. The braids 54 and 56 and the sleeve 58 all contribute to limiting bending.

A further modification is shown in Figures 9 and 10. This is similar to Figures 6 and 8 in that corrugated tubes 12*c* are utilized. The individual corrugated tubes are surrounded by braid 54*c*, and the hose body 14*c* is surrounded by braid 56*c*, the ends of the hose body being brazed or otherwise secured in place in coupling 16*c* similar to the couplings 16*b*.

Two points of difference are found in the hose illustrated in Figures 9 and 10, One important feature is that there is a cable 62 through the centre of the hose body. This cable preferably is made of wire for utmost strength, and serves to prevent elongation of the hose body, and also to limit bending of the hose. A further point of distinction in Figures 11 and 12 lies in the individual tubes 12*c*. These tubes, like the tubes 12*b* are corrugated, being provided with folded-over wall portions, however, the corrugations are not annularly arranged in the same sense as in Figure 6 and 8 (as specifically shown in Figure 11), but, as shown specifically in Figure 12, the corrugations 48 are helically arranged about the tube. Of course, it will be understood that the tubes could be interchanged, viz. the tubes having the annular corrugations could be used with the hose having the central cable, or the tubes having the helical corrugations could be used with the hose lacking the central cable. In any event, the corrugations of either type of tube broadly comprise convolutions.

Although the braid is illustrated only in combination with the corrugated tubes, it will be understood that the braid would have use with straight walled tubes. Likewise, the sleeve 58 could be used with the hose having a central cable, and a central cable could be use[redacted]th straight-walled tubes.

WHAT WE CLAIM IS:—

1. A hose comprising a plurality of small tubes in contiguous relation, a coupling joined to the tubes at one end of the tubes, the coupling being substantially larger in bore than the individual tubes, and means embracing the plurality of tubes and serving to limit bending of the hose construction.

2. A hose according to claim 1 wherein the small tubes are thin walled and flexible.

3. A hose according to claim 1 or claim 2 wherein the tubes are coterminous and wherein there are two couplings, one at each end of the tubes.

4. A hose according to any of claims 1 to 3 wherein the tubes are helically wound together.

5. A hose according to any of claims 1 to 4 wherein the coupling has a transverse wall with a plurality of holes therein in each of which one of the small tubes is received.

6. A hose according to any of claims 1 to 4 wherein the coupling has a generally cylindrical bore receiving the tubes, and further including a flowable material hardened in place securing the tubes in the bore.

7. A hose according to any of claims 1 to 6 wherein the tubes in cross section are arranged in a pattern in parallel rows.

8. A hose according to any of claims 1 to 7 wherein the means for limiting bending comprises a braided sleeve encircling all of the tubes.

9. A hose according to any of claims 1 to 7 wherein the means for limiting bending comprises a rigid sleeve encircling all of the tubes and flared outwards at one end.

10. A hose according to any of claims 1 to 9 wherein the means for limiting bending includes a cable extending longitudinally between the tubes.

11. A hose according to any of claims 1 to 10 wherein the small tubes are corrugated.

12. A hose according to any of claims 1 to 11 wherein each of the tubes is encircled by one of a plurality of braided sleeves.

13. A hose according to claim 1, substantially as described with reference to Figure 1 to 4, Figures 1 to 4 but modified according to Figure 5, Figures 6, 7 and 11, or Figures 9, 10 and 12 of the accompanying drawings.

For the Applicants:—
GILL, JENNINGS & EVERY,
Chartered Patent Agents,
51/52 Chancery Lane,
London, W.C.2.

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Fig. 1.

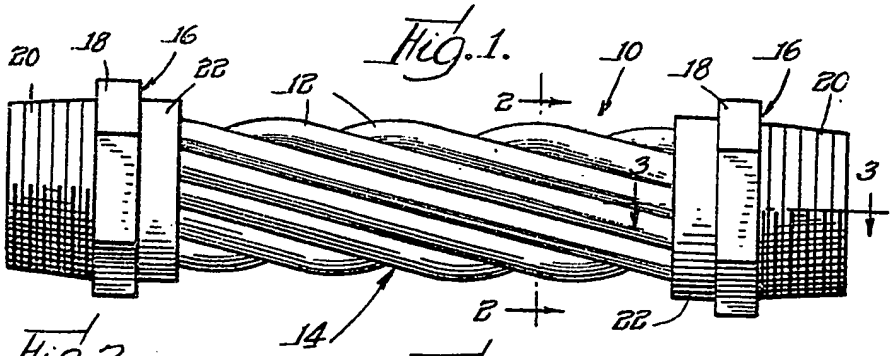


Fig. 2.

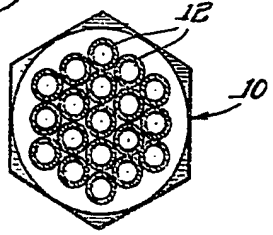


Fig. 3.

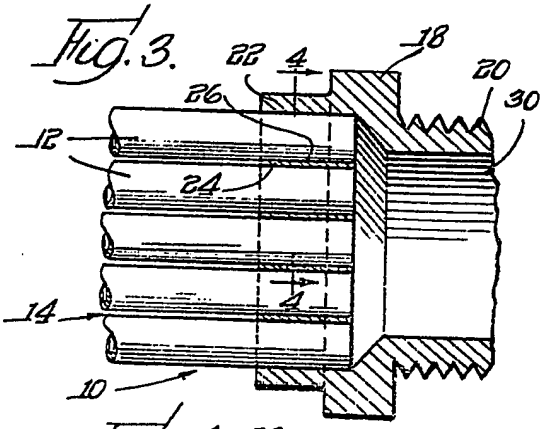


Fig. 5.

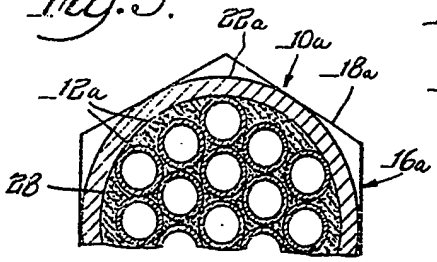
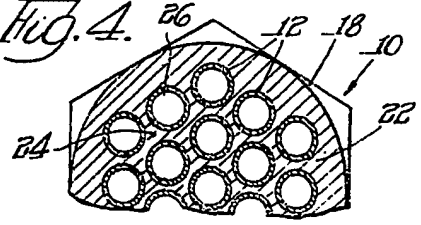


Fig. 4.



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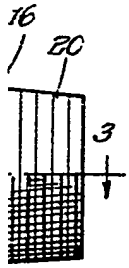
2 SHEETS

This drawing is a reproduction of the Original on a reduced scale.

SHEETS 1 & 2



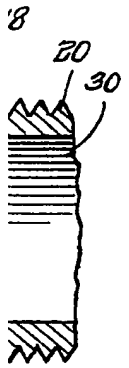


Fig. 6.

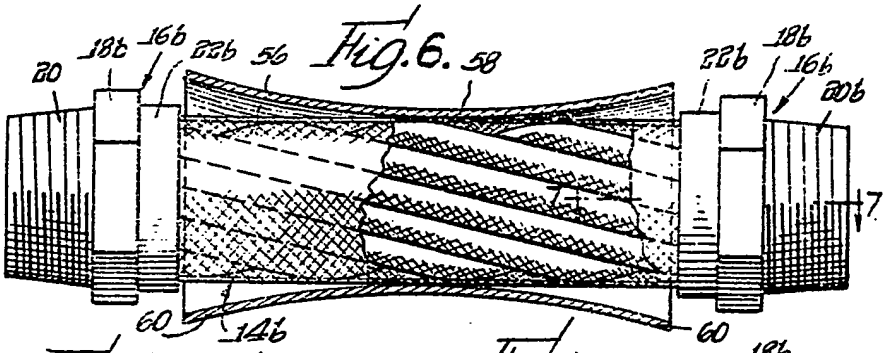


Fig. 8

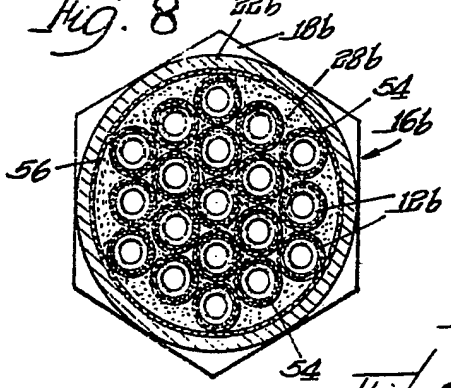


Fig. 7.

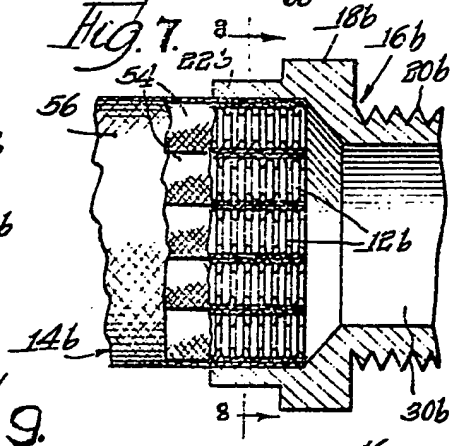


Fig. 9.

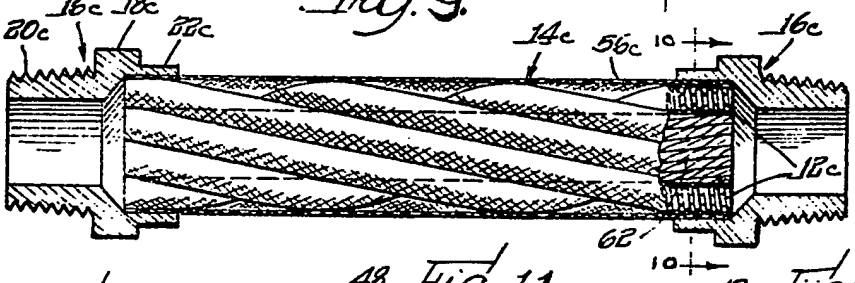


Fig. 10.

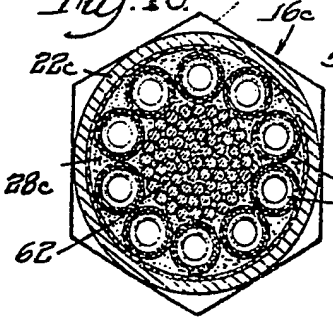


Fig. 11.

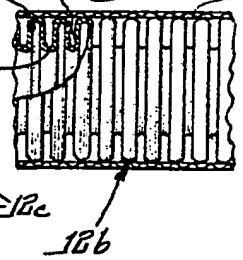
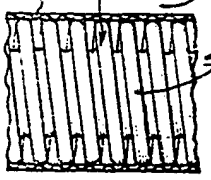


Fig. 12



838,070 COMPLETE SPECIFICATION
2 SHEETS

Fig. 1.

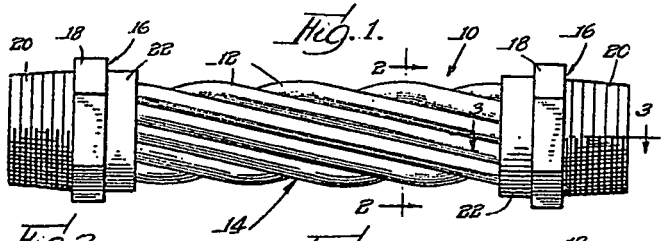


Fig. 2.

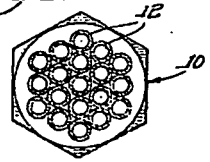


Fig. 3.

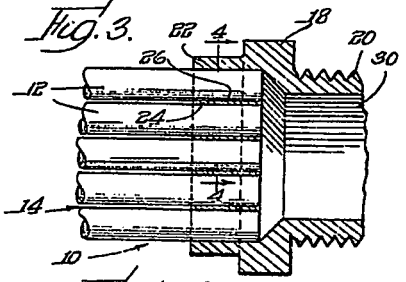


Fig. 5.

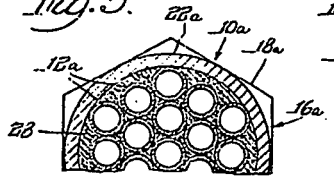


Fig. 4.

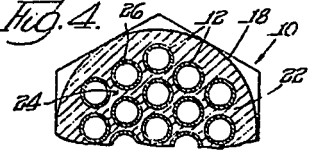


Fig. 6.

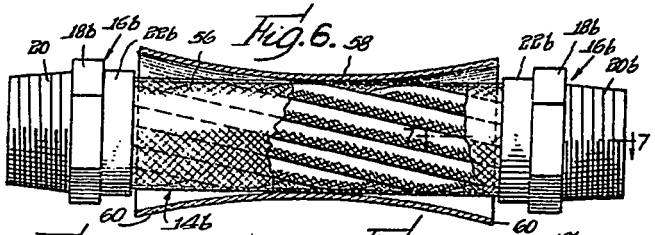
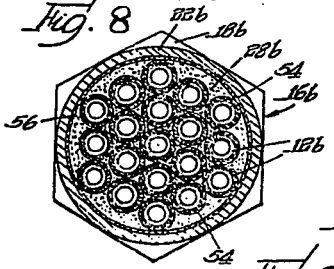


Fig. 8



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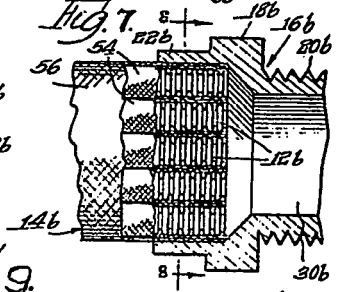

Fig. 9.

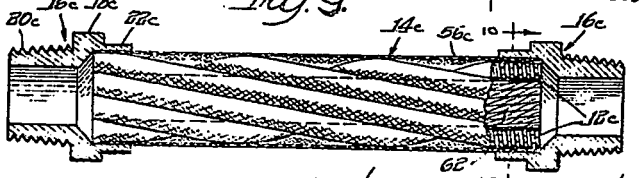

Fig. 10.

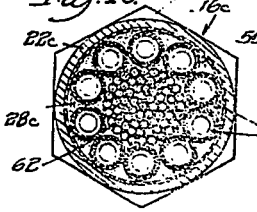

Fig. 11.

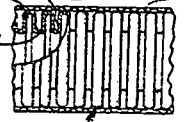

Fig. 12